and separately examined, proved absolutely free from the corpuscles that I had found in all the Anemones, with this doubtful exception: I found in one drop a single solitary corpuscle. But the presence of that one might safely be attributed to the fact, that I had previously returned one of the wounded animals to the vessel in question, and from this individual it had probably escaped.

Mr. Lewes suggests that possibly his predecessors in research had mistaken for blood-elements "the yellow spherical cells (?) which fill the tentacles of the adult Daisy, and make solid the tentacles of the *Anthea*." Of the function of these yellow spheres he confesses himself ignorant. The supposition is untenable. These spherules are pigment-cells, and they do not fill, far less make solid, the tentacles, but merely line their interior. These pigment-cells occurred in several of the experiments recorded above, and especially in the fluid obtained by incising the body of *Sagartia bellis*; but there is no possibility of confounding these with the morphotic corpuscles of the chylaqueous fluid: they differ notably in size, colour and structure. The corpuscles (in *Anthea*) average ·0002 inch in diameter; the pigment-cells are fully double this size: the corpuscles have a very faint yellow tinge, *seemingly* disks rather than spheres, with no definite walls, and composed of granulose substance; the pigment-cells are of a full but translucent golden-brown hue, very regularly globular in form, evidently spheres, and with a distinct wall.

It is not with any feeling of disrespect to either of the gentlemen named, that I forward these results for publication in the 'Annals.' The subject in question is one of considerable physiological importance; and as diametrically opposite conclusions have been arrived at by independent observers, and as it must be settled by the weight of testimony, I have thought it well to add my mite of evidence in favour of the affirmative side.

I am, Gentlemen,
Yours faithfully,
P. H. Gosse.

XIX.—*On the Formation of the Egg and Fertilization in the* Nematoidea. By Edouard Claparède*.

The dispute between Nelson, Bischoff and Meissner with regard to the formation and fertilization of the eggs in *Ascaris mystax*, has not yet attained any satisfactory solution. Not one of these three observers has retracted anything of his previous statements,

* Translated from Siebold and Kölliker's Zeitschrift für wissenschaftliche Zoologie, vol. ix. p. 106, by W. S. Dallas, F.L.S.

and each seems rather to assert positively that the right is on his side. It is to be regretted that the strife has not always been kept within scientific limits, and that passion has too often been allowed free play. By this means errors have certainly been produced, which otherwise might never have arisen.

A communication upon the subject in question has recently been published by Allan Thompson*, in which the author quietly considers the disputed points, and explains them with great accuracy. We regard this memoir as the best that has appeared upon the fecundation of *Ascaris mystax*. Thompson, a friend of Nelson's, has borne himself as impartially as possible in the discussion; nevertheless, a confirmation of statements by another likewise impartial observer might not appear to be undesirable, especially as Thompson was not acquainted with Schneider's observations upon the movements of the spermatozoa in the Nematoidea, and consequently has not referred to them. But if these observations be generalized, and if we assume that the *Amœba*-like movements of the zoosperms occur in all Nematoidea, it might seem improbable that the thimble-shaped corpuscles, which have been described as the seminal corpuscles of *Ascaris mystax* by Nelson, Meissner and Thompson, are the true zoosperms. These corpuscles have such a constant form, that we cannot well understand how they should move like *Amœbæ*, unless the extension and retraction of processes be limited to the flocculent end of the corpuscle.

1. *Histology of the Sexual Tube.*

It is above all things necessary to investigate the tissues occurring in the sexual tube of the Nematoidea more accurately, to enable us to decide the question whether epithelial structures occur, which do or do not agree with Bischoff's epithelial conules.

In the female the sexual tube consists of a membrane which is, at all events apparently, perfectly structureless. That its blind extremity consists of a series of cells fused together, as has been represented by Kölliker†, is certainly an error, the origin of which Reichert‡ has rightly sought for in phænomena of diffusion. The blind extremity is not unfrequently much thickened. A thickening of this kind occurs almost constantly in *Cucullanus elegans*, in an undetermined *Ascaris* from the small

* Zeitschr. für wiss. Zool. vol. viii. part 3.

† Beiträge zur Entwicklungsgeschichte wirbelloser Thiere. Müller's Archiv, 1847.

‡ Beitrag zur Entwicklungsgesch. der Samenkörperchen bei den Nematoden. Müller's Archiv, 1847.

intestine of *Triton tæniatus*, &c. Sometimes we have found the posterior extremity of the germ-stock very considerably thickened also in *Ascaris mystax*.

This structureless *tunica propria* is clothed upon the surface turned towards the lumen with an epithelium, as has already been described by Lieberkühn, Schneider, and Meissner in various Nematoidea. In most species this epithelium is very distinct in the vagina and uterus; its detection is more difficult in the oviduct and vitellogene. In the upper part of the latter and in the germ-stock we have been unable to discover an epithelial coat in any single Nematoid worm. Lieberkühn, also, who has accurately described the distribution of the epithelium in a worm from the proventriculus of *Fulica atra* and *Anas Boschas domestica**, has never been able to trace it to the uppermost part of the sexual tube.

In one species of *Ascaris* we have met with a form of epithelium, which, at the first glance, appeared to be in favour of Bischoff, in his dispute with Nelson and Meissner. This is the *Ascaris suilla*, from the intestine of the Pig. In this *Ascaris* the uteri as well as the oviducts are lined with large epithelial cells, 0·10 to 0·18 millim. in breadth, each of which is furnished with a process of 0·018 to 0·027 millim. in length, which projects into the lumen of the tube. The process is about as broad as long. It cannot be denied that there is a considerable resemblance between these processes and Bischoff's epithelial conules, except that the former are a good deal larger. But the *Ascaris* of the Pig is considerably larger than that of the Cat. The processes and conules, however, differ from each other in many respects. The latter only adhere very loosely to the wall of the genital tube, whilst the former are firmly attached to the epithelial cells; they are formed by a prolongation of the cell-membrane, and cannot be stripped off in any way. Most of Bischoff's epithelial conules are found free in the tube of *Ascaris mystax*, in consequence, we are told, of the weakness of the original union. But we could not succeed in separating the processes of *Ascaris suilla* from their foundation. Lastly, we have to mention one circumstance which sufficiently proves that the processes and conules have nothing to do with each other. In certain female individuals of *Ascaris suilla*,—and indeed, as we shall see hereafter, in the unfecundated individuals,—not only the processes of the epithelial cells, but also Bischoff's epithelial conules occur. The latter are considerably smaller than the processes, and it was impossible to detect any relation between them and the epithelium.

Meissner has already mentioned a villous epithelium in *Ascaris*

* Beiträge zur Anatomie der Nematoden. Müller's Archiv, 1855.

megalocephala, which is probably very similar to the above-described epithelial coat in *Ascaris suilla*.

In *Ascaris mystax* the epithelium presents nothing of the kind; it is rather perfectly smooth, and Nelson* has described and figured it very accurately. Notwithstanding the opposite statements of Bischoff and Leuckart, we have been unable, any more than Nelson, Meissner, and Thompson, to convince ourselves that the so-called epithelial conules ever adhere to the wall.

The outer surface of the *tunica propria* is clothed with a contractile layer in the lower part of the genital tube. In many species (*Ascaris suilla*, *A. mystax*, *Oxyuris vermicularis*, &c.) this layer consists of readily perceptible muscular fibres. In other species it appears to be perfectly structureless or simply granular, as Meissner has already remarked with reference to the uterus of *Mermis nigrescens* and various species of *Gordius*. Sometimes, however, as, for example, in *Cucullanus elegans*, an indefinite arrangement of the granules in transverse rows may be detected, from which we may very easily be led to suppose that these rows of granules represent difficultly visible muscular fibres. It was nevertheless impossible to prove the existence of these supposed muscular fibres by means of reagents.

Lastly, we should mention the granular longitudinal folds of the vitellogene in *Ascaris mystax*, which also occur in *A. suilla*. But as Nelson has connected these folds with the yelk-formation, we shall pay attention to them when we come to speak of the formation of the yelk.

The male genital tube is exactly of the same histological nature as that of the female, except that in the male *Ascaris suilla* the processes of the epithelial cells are wanting. In an *Ascaris* from the intestine of *Lota vulgaris*, which we regard as *A. mucronata*, the muscular layer consists of fusiform cells, which resemble the smooth muscular cells of the higher animals. Each cell is furnished with a nucleus of as much as 0·016 millim. in diameter, containing numerous nucleolar corpuscles. The portion of the male genital tube of *Ascaris suilla* which corresponds with the vitellogene of the female, is, like the latter, provided with granular longitudinal folds.

We will also mention that from three to four large oval cells occur at the base of the spicula in certain Nematoidea. Their signification is still perfectly problematical. Perhaps they must be regarded as simple glands. Such cells were found, for example, in *Ascaris suilla*, in which they even attain a length of 0·23 millim. In *Ascaris mucronata* they are about 0·18 millim. in length, but slender. According to an oral communication

* Reproduction of *Ascaris mystax*. Phil. Trans. part ii. 1855.

from Dr. Guido Wagener, he has also detected similar structures in various Nematoid worms.

2. *Formation of the Eggs.*

The Nematoidea may be divided into two sections as regards the mode of formation of the eggs. One of these sections includes those species whose eggs are arranged round a central rhachis in the vitellogene; the other is formed by those species which possess no rhachis. As a general rule, it may be asserted, that all the Nematoidea in which the vitellogene exhibits several eggs in the same transverse section, belong to the first category; whilst those in which each transverse section only hits upon a single egg, are to be referred to the second. We shall occupy ourselves especially with the species of the first section. Here we again meet with the *Ascaris mystax*, at once so celebrated and notorious, and with it the *Ascaris suilla*. We shall select the latter in preference as the subject of our investigation, as it is better adapted for this purpose than the former. The rhachis is much thicker in it than in *A. mystax*, and shines through the walls of the organ in the axis of the vitellogene, in the form of a dark column.

Like Bischoff and Thompson, we have been unable to find Meissner's female germ-cells. The germ-stock is full of vesicular elements, which subsequently become the germinal vesicles of the eggs in course of formation. But no appearances which might have been in any way favourable to Meissner's view, were ever observed. It is true that the mode in which the germinal vesicles are first produced could not be ascertained, and we only consider it probable that they increase by division. We think we must contradict Nelson's statement, according to which the germinal spots are first produced, and subsequently surround themselves with a membrane to form the germinal vesicles.

As the germinal vesicles descend in the genital tube, they surround themselves with a granular substance, the first rudiment of the yelk. At the point where this deposit first takes place, the vitellogene properly begins. There is, however, no true boundary between the germ-stock and vitellogene. Even in the so-called germ-stock the germinal vesicles are united to each other by a tenacious transparent substance, which is nothing but the first commencement of the yelk-deposit. Within this tenacious fundamental substance, small granules gradually make their appearance,—these are the first yelk-granules, which soon become so extremely numerous that it is no longer possible to recognize the germinal vesicle. The contents of the ovarian tube then appear uniformly granular. When the tube is cut

through, the contents flow forth in the form of a coherent mass. If we now examine a portion of the tube situated rather lower down, we find larger granules arranged in the axis of the organ. These form the first commencement of the rhachis, which gradually becomes broader and darker, whilst the periphery of the contained mass appears mamillated. When the genital tube is torn up with needles, this contained mass is observed to consist of pyramidal eggs, of which the apices adhere to the rhachis, whilst their bases form hemispherical elevations at the periphery. The question now is, whether this rhachis be a true one, or only apparent, as Meissner asserts. The rhachis is a true one; upon this point there can be no doubt. In *Ascaris suilla*, in which the rhachis is very thick, it is easy, by means of needles, to strip off most of the eggs from the rhachis, and obtain long pieces of the latter in a free state. We may then convince ourselves that the rhachis really forms a continuous column, and that it does not consist of a series of germinal cells. In *Ascaris mystax*, in which the rhachis is much thinner, this preparation does not certainly succeed so easily; but here also the conditions are exactly the same. Both in *Ascaris mystax* and in *A. suilla*, but especially in the latter, it is easy to obtain the stellate groups of eggs which Meissner has figured and described as germ-cells with eggs adhering to them. These, however, are mere artificial productions, which may be prepared at pleasure by tearing away small pieces of the rhachis. It is very remarkable that Meissner, although he discerned this circumstance very accurately in *Strongylus armatus*, nevertheless still maintains his perfectly false theory.

Bischoff and Meissner have disputed gallantly as to whether the eggs are or are not furnished with a vitelline membrane within the vitellogene. In our opinion, however, this is a trifling dispute, which has already cost far too many words, but has thriven to such an extent, that it must cost a few more. It might have been desirable that the combatants, before arming themselves for the battle, had first ascertained clearly what they understood by *membrane*. This is a notion that forces itself upon us involuntarily when we read Thompson's memoir. This observer denies* the existence of the membrane, because the surface of the eggs appears exactly like that of a Proteus (*Amœba*). But the difficulty is by no means got rid of in this way, for there is no question so unsettled at present, as that of the presence or absence of an enveloping membrane in the *Amœbæ*. It is only recently that Auerbach† has brought forward reasons in

* *Loc. cit.* p. 435.

† Ueber die Einzelligkeit der Amœben. Zeitschrift für wiss. Zool. Bd. vii. Heft 4.

favour of its presence. Supposing, therefore, that Auerbach's opinion be correct, Thompson's observation would no longer tend to support Nelson, but would rather speak unexpectedly in favour of Meissner.

A membrane is a thin layer of a substance, the chemical or physical properties of which (tenacity, firmness, density, &c.) are sharply distinguished from those of the media in contact with it on both sides. The periphery of an *Amœba* is undoubtedly formed by a layer of greater density than the rest of the parenchyma of the body. But it seems not improbable that the parenchyma increases gradually in density from within outwards, and that the external denser layer is not clearly defined towards the inner, softer parenchyma. In this case no true membrane is present. We can only speak of a denser layer or region. Mohl has already noticed this condition in plants, and distinguished every dense outer layer, which cannot be clearly separated from the inner substance, by the name of *pellicula*, in opposition to the idea of a *membrane*. The term pellicula is perhaps not very happily chosen.

In our opinion, the eggs of *Ascaris mystax* and *A. suilla* are in this respect in the same condition as the *Amœbæ*. We have to distinguish two different things in the yelk,—in the first place the vitelline granules, and then a transparent, colourless, uniting, intermediate substance. The outer layer of the eggs is formed only of the latter; no vitelline granules are contained in it. Of this layer Meissner has made his vitelline membrane. It is, however, as already stated, not a membrane, but only the intermediate substance, becoming more and more dense externally. It is just because this intermediate substance has a greater density at the periphery, that the vitelline granules do not penetrate into the outer layer.

All observers agree that the eggs are surrounded by a membrane in the lower part of the tube. This membrane is produced by the outer granule-less layer of the yelk becoming sharply defined in opposition to the interior of the egg. But where the differentiation commences, it is difficult to say. For this reason Bischoff may, to a certain extent, be right in asserting, that the eggs in the vitellogene are not surrounded by a membrane, as the membrane is not yet perceptibly differentiated from the yelk. On the other hand, Meissner is not quite in the wrong in maintaining the presence of the membrane, as it is already in course of formation. Whilst, according to Meissner, the vitelline granules are formed in his supposed germ-cells, Nelson and Bischoff, on the contrary, see the place of formation of these granules in the granular longitudinal processes of the vitellogene. Thompson, who supposes that the deposition of the vitel-

line substance takes place from without, proceeds more cautiously, and does not venture to decide in any way as to the place of formation of the vitelline granules. We do not believe that the vitelline granules can be formed by the longitudinal processes, because free vitelline granules never occur between the wall of the genital tube and the column of ova. Moreover, the granules would have to penetrate first of all into the outer granule-less layer of the yelk, if the deposition took place from without; but nothing of the kind is observed. It is not to be doubted that in the upper part of the genital tube the granules are formed all round the germinal vesicle; but as soon as the rhachis makes its appearance, it seems to us that this must be considered as the place of formation of the vitelline granules. It is (in *Ascaris suilla*) comparatively very broad and densely filled with vitelline granules; more densely, in fact, than the eggs themselves. In the lower part of the vitellogene, at the point where the eggs separate by constriction, the rhachis disappears. What, then, has become of its contents? They have passed into the corresponding ova; and we believe that every new vitelline granule that appears in an egg has come over from the rhachis. This view does not differ much from that of Meissner. In either case, the vitelline granules are produced in the rhachis; but in the one case the rhachis is real, in the other apparent.

The question of the micropyle in the ova of the *Ascarides* is one of great importance, as Meissner's theory of fecundation entirely depends upon it. A micropyle, such as is described by Meissner—that is to say, an aperture in a membrane—certainly does not exist, as we cannot detect any true membrane. Meissner's theory is not, indeed, compromised by this, as a fissure in the external, denser, vitelline layer might very well perform the function of a true micropyle. But we cannot admit the micropyle even in this limited sense. The ovum gradually separates itself from the rhachis by constriction, so that the bridge of connexion between the two becomes thinner by degrees, and at last disappears. There then remains no fissure in the outer layer, but the place of the pretended micropyle is clothed, like the rest of the egg, with this layer.

The changes which the egg undergoes in the lower part of the oviduct will be referred to hereafter, at the same time with the fecundation.

Amongst the Nematoidea in the vitellogene of which a rhachis is to be met with, we shall also mention *Cucullanus elegans*. Siebold, even in his 'Comparative Anatomy,' places this worm amongst those which have a rhachis in the vitellogene, but says nothing further upon it. It must therefore appear strange that

the two authors who have studied the eggs of *Cucullanus elegans* most in detail, namely Kölliker* and Gabriel†, do not say a word about a rhachis. The blind extremity of the tube of the ovary in *Cucullanus* is filled with clear vesicles,—the germinal vesicles with their germinal spots. Between these vesicles there is even there a transparent substance, by which they are enveloped. This is the first commencement of yelk-formation, and, with a little attention, we may already distinguish delicate lines, which bound the ovules. A distinction of germ-stock and vitellogene is therefore here practically quite impossible. That the germinal vesicles are destitute of germinal spots in the upper half of the ovary, as is asserted by Gabriel, is certainly not the case. This naturalist has even accused Bagge of error, because he stated that he observed the germinal spots in the germ-stock of *Strongylus auricularis* and *Ascaris acuminata*. But any one may easily convince himself of the correctness of Bagge's statement. On the other hand, we have not been able to confirm Kölliker's observation, according to which the germinal spots are produced before the germinal vesicles themselves.

As the eggs progress downwards in the genital tube, they increase quickly in diameter in consequence of the rapid formation of the colourless transparent yelk: they then form a coherent mass. When an egg is torn away from this mass, it is found to have a pyriform shape and a short thin stalk. By the careful treatment of the mass of eggs with needles, or by gentle pressure with the thin glass cover, the eggs may not unfrequently be separated, so that we may perceive how they form an elegant bunch. The bunch consists, as it were, of extremely thin, delicate branches, and thick berries. In the axis of the genital tube the little branches come together, and form a main stem, the rhachis, which is here very thin. As this rhachis and its branches are not only very delicate, but also, like the vitelline substance in *Cucullanus elegans*, colourless, they are not always easily perceptible. They become so immediately, however, when the bunches of eggs are coloured by solution of iodine.

We shall not speak here of those Nematoid worms in which the vitellogene always contains only a single series of eggs, as the egg-formation in these has already been sufficiently explained by Siebold and Bagge.

3. *Formation of the Seminal Corpuscles.*

With regard to the formation of the seminal corpuscles, we

* *Loc. cit.* Müller's Archiv, 1843.

† De *Cucullani elegantis* vivipari evolutione. Auctore Benno Gabriel. Berolini, 1853.

come at once upon a dispute, the counterpart of that which we have already referred to in connexion with the formation of the ovum. Some assert that the seminal corpuscles are from the first surrounded by a membrane; others will not admit the existence of this membrane. The principal supporters of the latter opinion are Siebold, Nelson, Bischoff, and Thompson. Reichert and Meissner hold the former. Here, again, the truth appears to lie in the middle, or, if it be preferred, on both sides.

The turning-point of the whole discussion is formed again in this case by *Ascaris mystax*. Unfortunately, we have had but few cats at our disposal, and in these we only found female *Ascarides*. As, however, we have obtained male individuals of *Ascaris suilla*, this deficiency is easily got over. The mature seminal corpuscles of the two species are so much alike, that it is perfectly impossible to distinguish them; we may therefore well suppose that the course of development will be essentially the same in both cases.

The blind extremity of the genital tube is full of small colourless vesicles. There can be no question about Meissner's male germ-cells. It was as impossible for us as for Nelson, Bischoff, and Thompson to find them, and it is not probable that they could have escaped so many observers. As the colourless vesicles progress downwards in the genital tube, they surround themselves with a granular mass, which consists of strongly refractive granules and a colourless connecting substance. The contents of the male genital tube are then perfectly similar to those of the vitellogene, and the more so as the seminal corpuscles in formation are of a pyriform shape, with their apices directed towards the axis of the organ. The apices adhere more or less to each other, but a true rhachis is not produced by this means. Each corpuscle now appears like an egg; the clear vesicle shines through, like a germinal vesicle through the yelk. This deposition of granules was first described by Siebold in *Ascaris paucipara*. It was, however, controverted, evidently incorrectly, by Reichert; but the latter observed *Strongylus auricularis* and *Ascaris acuminata*, in which the seminal elements are comparatively small. In *Ascaris paucipara* and *Ascaris suilla*, on the other hand, the various stages of development of the seminal elements are considerably larger, so that they permit observations to be made with much greater certainty.

In the lower part of the testis, the corpuscles which were previously pyriform, or rather pyramidal, become rounded; the nucleus (the clear vesicle) disappears altogether. Each corpuscle then forms a granular sphere. The granules soon pass to one particular side of the globule, so that it then represents a clear, transparent sphere, furnished with an aggregation of granules

at a certain spot in its periphery. This is the stage that corresponds with Meissner's mature germ-cells. The sphere then exhibits a very sharp outline, "a well-defined margin," as Nelson says. Nevertheless Bischoff here again denies the existence of a membrane, and calls the sphere a sarcode-globule. The question is a difficult one to decide. We should declare ourselves decidedly against the assumption of an enveloping membrane, so long as the deposition of granules around the original vesicle is still going on. But whether the outer layer of the spheres does or does not harden into a membrane in the lower part of the testis, or in the so-called *ductus deferens*, it is difficult to decide. We are inclined to believe that the same conditions occur here as with the ova in the vitellogene, and that the sphere gradually increases in density towards the periphery.

Nelson asserts that the nuclei (the original clear vesicles) of the corpuscles are persistent, so as to free themselves from their granular envelope within the female genitalia, and reappear as *spermatic cells*. This is certainly an error. The nucleus disappears very early, and no trace of it is then to be found.

Hitherto no further development of the seminal corpuscles in the male genitalia has been observed. The following stages have always been met with in the female sexual organs. We have, however, been more fortunate than previous observers, inasmuch as we have been able to trace the development of the seminal corpuscles further in the seminal sac of *Ascaris suilla*. After the clear globules with accumulations of granules have increased by division, they reach the seminal vesicle; they may then be regarded as development-cells of the zoospermia. From any point of the aggregation of granules there rises a small arched process, which gradually grows up into a finger-shaped body. We have not been able to observe that this process carries a membrane forward with it, by which the question of the presence or absence of the membrane might have been solved. The sphere rather separates very soon, so that the aggregation of granules with its attached finger-like body becomes free. It is not rare to meet with aggregations of granules which bear from two to four finger-like bodies, although we have been unable to ascertain that all these bodies originate from a single cell. It is possible that such groups are produced by several aggregations of granules adhering to each other, and as it were becoming amalgamated. However, we have never observed that the aggregations bearing several finger-like processes were larger than those which were furnished with a single one. Lastly, we find loose finger-like corpuscles, which are no longer adherent to the granular aggregations. These have the greatest resemblance to the thimble-like corpuscles, which are

found in the female genitalia (Bischoff's *epithelial conules*), except that they are rather longer. This difference, however, is of no consequence, if we consider that the thimble-like corpuscles of the female are furnished with a flocculent tuft at one extremity. Supposing that a small portion of the finger-like body acquires a flocculent nature, it will be impossible to distinguish it from a thimble-like corpuscle. No further development was observed within the male genitalia.

Bischoff has asserted that he has again met with his epithelial conules, although of a different form, in *Strongylus auricularis* and *Ascaris nigro-venosa*. In *Strongylus auricularis* the conical seminal corpuscles, first described by Bagge and Reichert, occur not only in the female, but also, in masses, in the male sexual organs. They were never observed adhering to the walls of the genital tube. The development of these corpuscles is rather complicated, and our observations upon it do not agree perfectly with those of Reichert. Reichert took up the idea that the parts of most zoospermia, namely the head and tail, are to be found in the seminal corpuscles of *Strongylus auricularis*, by which many errors have been produced. Such a comparison between these seminal corpuscles and the tailed zoospermia is inadmissible. In the latter the tail is the moving, and the head the passively moved part. We shall see hereafter that, when the seminal corpuscles of *Strongylus auricularis* begin to move, the part that moves is exactly that to which Reichert gave the name of the head, whilst the so-called tail is trailed along.

We shall content ourselves for the present with these observations, without entering upon a more exact description of the process of development of these seminal corpuscles. We shall only add, that the last stage of development which is met with in the males, forms bodies which may be compared with an elongated cone, or perhaps better, as the tips are usually bent round, with the horn of a chamois.

4. *Of the Fecundation.*

It is one of the most beautiful results of modern physiology that several observers have succeeded in proving, in various animals, that the penetration of one or more zoospermia into the ovum is the first condition of impregnation. It might, however, at present, be somewhat precipitate, if we were to set up the general proposition that no fecundation is possible without the direct penetration of the spermatozoon itself. We need only refer to the immense zoospermia of certain Salamanders, and especially to those of the species of *Cypris*, which are so uncommonly large, that they not only considerably exceed the egg, but

even the mature animal itself, in length. Such instances render it not improbable, that under certain circumstances it is not the spermatozoon itself, but only a portion of it, or an emanation from it, that takes part in the penetration.

Amongst the species in which the penetration of the zoospermia into the ovum has been observed, *Ascaris mystax* has occupied a leading place. It is now necessary that we should examine how far we may attach unconditional credit to the observations of Nelson and Meissner with regard to this penetration.

Two questions force themselves upon us: first, are the corpuscles, which, according to Nelson and Meissner, effect the fecundation, the true zoospermia? and, secondly, do these corpuscles actually penetrate into the egg; or, at least, are the observations of Nelson and Meissner upon their penetration decisive?

We have already indicated how we answer the first question. Upon this point we agree perfectly with Nelson and Meissner, and regard the thimble-like corpuscles as true zoospermia. It has already been shown that these corpuscles have nothing to do with the epithelium; but this by no means proves that they are in any way connected with the act of fecundation. In the elucidation of this question we have derived great advantage from the unfertilized females. All the females of *Ascaris mystax* that we have investigated were indeed fecundated, as could easily be perceived from the alterations which had taken place in the eggs. On the other hand, we have obtained more than twenty females of *Ascaris suilla*, in which the eggs did not exhibit the slightest alteration that could be referred to an influence of impregnation, and for this reason we have regarded these females as unfertilized. There were two females from the Pig, whose ova, to judge from the changes which they had already undergone, were evidently fecundated. It was remarkable that not one of the former *Ascarides* contained thimble-like corpuscles in their genitalia. In the two latter, on the contrary, the oviduct was closely filled with them. Our friend Dr. de la Valette has observed an exactly similar fact in *Ascaris mystax*. He found a female which, from the condition of the ova, he could not but regard as unimpregnated, and it did not contain a single thimble-like corpuscle. If, on the one hand, we bear these facts in mind, and, on the other, realize the extreme similarity which exists between the last stages of development of the zoospermia in the male sexual organs of *Ascaris suilla*, and the thimble-like bodies in question, we must be convinced that the latter are the true mature spermatozoa. That the sharply truncated extremity of the finger-like seminal corpuscle of the male acquires a floccu-

lent structure when this corpuscle reaches the female generative organs, and becomes the flocculent end of the thimble-like zoospermion, has not indeed been as yet observed directly. But the probability of this change becomes elevated into certainty by the fact, that we have directly observed an exactly similar process in the seminal corpuscles of *Strongylus auricularis*.

It is deserving of notice that these facts were not entirely unknown to Bischoff. He has had an *Ascaris mystax* in his hands the eggs* of which were to all appearance unfecundated, and its sexual organs also contained none of the so-called epithelial conules. Nevertheless, Bischoff firmly retained his opinion, and supposed that the conules were wanting because the female was immature. He thinks to find a proof of this in the fact that the eggs appeared quite otherwise than in other cases; the chorion was not granular as usual, but lamellose and thin. This is no proof; but nevertheless the observation is interesting, as we shall show immediately that in many Nematoidea the want of fecundation superinduces the formation of an abnormal chorion.

That the unfertilized *Ascarides* observed by us were not immature, is perfectly certain. Most of them were very large; many of them even very considerably exceeded the maximum of length to which this species is otherwise restricted.

The fate of the ova in *Ascaris suilla* is different, according as they are fertilized or not. We shall in the first place consider the fertilized egg.

As soon as the egg has passed the spot where the fertilization takes place, it surrounds itself with a distinct membrane. This is no new formation, no structure secreted from the tube; it rather appears to us that this membrane is only produced by a sharper differentiation of the outer denser layer which has already been referred to. At any rate, the formation of this membrane is no immediate consequence of fecundation, for it also occurs in the unimpregnated female. But in the latter this membrane appeared to be thinner and more delicate. Around this membrane a second is formed, the chorion, probably secreted by the walls of the genital tube. This chorion attains a considerable thickness, and is smooth on the surface. At the same time, a molecular change shows itself in the interior of the yelk. Before fecundation the latter was perfectly opake, and consequently appeared nearly black under the microscope. But after fertilization the vitelline granules gradually become less refractive, and the yelk thus appears paler and more transparent. At the same time a clear vesicle becomes visible in the midst of it.

In the unimpregnated female the egg does not properly sur-

* Ueber Ei- und Samenbildung und Befruchtung bei *Ascaris mystax*. Zeitschr. für wiss. Zool., February 1855.

round itself with any second membrane. In place of it there is a deposition of a thick layer of a flocculent, whitish substance, appearing something like loose cotton wool. This layer never solidifies into a true chorion. Between the eggs there are here and there loose lumps of this peculiar substance. Small refractive corpuscles are now and then lodged in them. These unfecundated eggs always remain dark, and never become clear; nor do they usually acquire such a regular oval form as the fertilized ones.

This action of the fertilizing corpuscles upon the formation of the chorion presents the more interest, as it reminds us of an exactly similar phænomenon in botany. Pringsheim*, as is well known, has discovered that the resting-spores of the *Vaucheriæ* lie first of all perfectly naked in the sporangium, and only surround themselves with a membrane when the spermatozoids have penetrated through the micropyle into the sporangium. Pringsheim† has made exactly similar observations in *Œdogonium*.

We cannot here omit again mentioning the unimpregnated *Ascaris mystax* which was observed by Bischoff, the eggs of which, according to the statements of this observer, possessed an abnormal, not granular, but lamellar chorion. Nelson had already called attention to a distinction in the structure of the chorion in the eggs of *Ascaris mystax*, according as they have or have not been fecundated. His statements, however, differ from those of Bischoff. He describes the chorion of his 'false,' that is to say, unfertilized eggs, as granular, whilst that of the fecundated eggs is perfectly smooth. Here we must declare ourselves decidedly in opposition to Nelson. The females of *Ascaris mystax* that were at our disposal were all impregnated, but in not one of them did the chorion appear smooth, but always exhibited a very distinct structure. With a strong magnifying power, this structure proved to be a delicate division of the surface into facets. The facets are of the form of watch-glasses, and slightly concave; they are visible both on the inner and outer surface of the chorion. They are larger or smaller according to the individuals. When they are very small, it is not easy to recognize what is before us, and we may then be misled into characterizing the structure as granular, or to suppose that there are very fine canals in the chorion. But whenever individuals are met with in which the facets are 0·004–0·005 millim. in breadth, no further doubt is possible. It must therefore

* Ueber die Befruchtung der Algen. Monatsbericht der Berl. Akad., March 1855.

† Monatsbericht der Berl. Akad. 1856.

remain uncertain whether Nelson's "false eggs" had really escaped fecundation.

It is by no means our intention to represent this influence of the act of fecundation upon the formation of the chorion as universal. There are Nematoid worms in which the eggs surround themselves with a perfectly regular chorion, even in the unimpregnated females,—as, for example, *Oxyuris vermicularis* and many others.

We have turned our attention particularly to the mode in which the fecundation is effected, but without being able to arrive at any positive result. Nothing, especially, could be discovered from which it might be concluded with some probability that the zoospermia penetrate into the yelk. It is a recognized principle that a positive observation cannot be subverted by a negative one; and for this reason we shall by no means declare the statements of Nelson and Meissner to be improbable. We may nevertheless be permitted to subject the investigations of both observers to a sound criticism, in order to see how far they can endure a close examination, and whether they really prove what they profess to do.

Supposing that the thimble-like corpuscles penetrate into the yelk, the most important question is, whether this penetration takes place in accordance with the description of Nelson or that of Meissner. Nelson found numerous seminal corpuscles adhering to the surface of the eggs, which we readily believe, as these corpuscles very easily adhere to foreign objects by means of their flocculent extremity. This adhesion to all possible bodies is even the cause of the error into which Bischoff, Leuckart, and Eckhard have fallen. Nelson, however, goes still further, and says that he has seen how the seminal corpuscles pressed-in the surface of the yelk, and finally penetrated into it from all sides. There is no doubt that Nelson's figure and description are accurate. Nevertheless, it is a question whether this observer had to do with a natural or with an accidental phænomenon. If we closely examine Nelson's figure, we cannot avoid considering the latter as the more probable. It evidently represents crushed eggs,—and that zoospermia should get accidentally into a crushed egg, cannot be considered strange. Thompson has been more careful than his friend: he has certainly observed the adhesion of the seminal corpuscles on the surface of the eggs and fissures in the outer layer of the vitellus, but he does not venture to assert that he has seen seminal corpuscles in the vitellus itself,—nay, he does not even believe that these phænomena must necessarily be brought in connexion with the act of fecundation. It appears to us, however, that Nelson and Thompson made their observations through the walls of the ovi-

duct itself. This mode of observation is certainly not to be neglected, in order to detect the mutual position of the different parts of the contents; but it is not sufficient, as, on account of the opacity [of the walls], it necessitates a tolerably strong pressure, and consequently an injury to the object. When the walls of the oviduct are cut open under pure water, or slightly salt water, which is better, so that the eggs flow out without force, we do not meet with the eggs with torn surfaces, which Nelson figures. We then see, also, that the adhesion of the seminal corpuscles to the eggs is by no means so frequent as is asserted by the two English observers. We may particularly convince ourselves that this adhesion is effected solely by means of the flocculent extremity.

We therefore think that we must agree with Meissner, when he disputes Nelson's description of the penetration of the seminal corpuscle into the yelk. It still remains for us to examine whether Meissner's representation itself may have a greater right to our support.

It has already been shown that Meissner's micropyle does not exist. This, however, by no means proves that the zoospermia do not penetrate into the yelk exactly at the spot where Meissner has supposed his so-called micropyle to be. Meissner asserts that the seminal corpuscles adhere much more frequently on the place of the pretended micropyle than on any other, and that this adhesion is facilitated by the hood of the corpuscle. This observer, as will be remembered, describes the formation of the seminal corpuscles in a way very different from ours: he makes the formation of the seminal corpuscle take place within the development-cell. As it grows, it must acquire a crooked form, until, suddenly extending itself, its anterior extremity passes through the cell-membrane. In this way the latter is not lost, but remains attached to the corpuscle as a hood. This hood we have, however, been unable to see, and we must entirely dispute its existence. Only once, amongst thousands of seminal corpuscles of *Ascaris mystax*, did one occur, which agreed pretty well with Meissner's figures, and was provided with a hood. In this isolated case, however, we can only see an abnormal formation.

Meissner has figured several eggs upon the pretended micropyle of which a seminal corpuscle is seated. Without wishing to doubt the correctness of the figures, we must still say, that nothing of the kind has ever occurred to us. On the contrary, we repeatedly observed a phænomenon in *Ascaris suilla* which may perhaps throw a perfectly different light upon Meissner's drawings. Thus, in unimpregnated females, ova are not unfrequently met with, which, although their vitelline membrane is

already formed, still present the pyramidal form, and have the apex very long. Such an egg completely reminds one of Meissner's drawings of eggs with seminal corpuscles seated upon the micropyle. Sometimes the vitellus draws back a little from the membrane at the apex, and then the resemblance to one of Meissner's seminal corpuscles, with its hood on, becomes still greater. Nevertheless, it is certain that this process is the apex of the egg, and not a seminal corpuscle; for this observation was always made upon females the sexual organs of which otherwise contained nothing that could be regarded as a seminal corpuscle. Closer observation shows also that we have to do here with an extrusion of part of the yelk. The apex gradually becomes constricted, so that at last it is only connected with the ovum by a narrow neck. A false chorion is then deposited around the portion separated by constriction, just as around the unfecundated egg. For this reason we often find, in the females of *Ascaris suilla*, besides the ordinary eggs, an immense number of corpuscles which are formed exactly like the eggs, but excessively minute. These are not abortive ova, but portions of yelk thrown off from eggs of normal size. This is a phænomenon agreeing with the separation of a small fragment of vitelline matter, which has already been observed in many animals. F. Müller's so-called vesicle of direction is nothing but an extruded portion of yelk of this description. We will not assert that such eggs as those just described have furnished the foundation for Meissner's figures, but this is not very improbable.

What is most in Meissner's favour is his statement, that he has seen undoubted seminal corpuscles in the interior of ova. We have no right to doubt the correctness of such a statement, although the unmistakeable recognition of a seminal corpuscle within the yelk may not always be a very easy matter. If Meissner has actually met with seminal corpuscles in certainly uninjured ova, this is an incontestable proof that the zoospermia, by some way or other, penetrate into the egg. Only one of Meissner's figures represents an undoubted seminal corpuscle within the egg. In the text, however, the author states that he has sometimes met with three or four seminal corpuscles in the same egg of *Ascaris mystax*, and that he has since convinced himself (especially in *Ascaris megalocephala*) that several spermatozoa (sometimes even ten) usually penetrate into the same egg. Unfortunately, it is not evident whether this assertion rests upon direct observation, or whether the author has concluded that there is a simultaneous penetration of several seminal corpuscles, from the fact of his finding the supposed products of their metamorphosis in the eggs. If the last alternative be correct, as appears to be probable, the whole theory of fecundation

set up by Meissner stands upon a very weak footing, as will be shown immediately.

Both Nelson and Meissner saw the seminal corpuscles undergo very important alterations after their penetration into the yelk. According to Nelson's statement, they lose their characteristic form, and become converted at last into irregular, transparent, but strongly refractive masses. Meissner groups these changes together as a gradual fatty metamorphosis. According to him, the seminal corpuscle gradually undergoes a conversion into a drop of fat.

At the first glance we cannot avoid seeing a great concordance in the representations of the two writers,—a concordance which must apparently be indicated as in favour of the observation, all the more because in other respects the two observers above mentioned do not usually take the same path. This agreement is, however, only apparent. It will be remembered that Nelson supposed that in every female a certain number of ova escape fecundation. These are his "false eggs." According to Nelson's statement, symptoms of retrogression soon appear in them. The germinal vesicle disappears, and in its place a certain number of transparent globules, which look like oil-drops, make their appearance. The author thinks that these globules are a product, on the one hand, of the germinal vesicle that has disappeared, and, on the other, of an incipient separation between the vitelline oil and granules. He adds, that these drops cannot be confounded with the small masses produced by the conversion of the seminal corpuscles, because the latter are of an irregular form, and never exhibit the uniform outline of an oil-drop.

We now see that the oil-drops in Nelson's "false eggs" have a much greater resemblance to Meissner's zoospermia converted into fat, than the masses which are produced, according to Nelson, by the metamorphosis of the zoospermia. Meissner has also acknowledged this, and for this reason he denies that Nelson's "false eggs" were unfecundated. The oil-drops contained therein are, with him, metamorphosed seminal corpuscles.

Amongst all these mutually contradictory statements we are in a position to confirm only those of Nelson with regard to his "false eggs" with certainty. If Meissner's theory were correct, every egg, or nearly every egg, in the lower part of the tuba and in the commencement of the uterus, should contain one or several oil-drops. This, however, is by no means the case. It is by far the smallest number of eggs that contain such drops. On the other hand, in the *unimpregnated* females of *Ascaris suilla*, we could trace the formation of oil-drops in a far greater proportion. Not unfrequently, individuals are met with, in the uterus of which most of the eggs are furnished with one or

several drops. These drops are perfectly identical with Meissner's. They are not unfrequently met with larger than four or five seminal corpuscles taken together. Here again, therefore, the study of the unimpregnated females proves of great advantage, and it is to be regretted that it was neglected by previous observers. It is not improbable that the appearance of oil-drops in the egg is to be regarded as a sign of its having missed its object, and that it is destined to die and become retrograde. We cannot assert that the few eggs in impregnated females in which oil-drops are formed have escaped fecundation, for these are also surrounded with the normal chorion, which is only formed after fecundation has taken place. But we may easily imagine that a fecundated egg may from some cause become aborted, and die. It is therefore not impossible that the eggs in question are to be regarded as abortive.

We have received from a friend a confirmation of our observations:—Dr. de la Valette obtained an unimpregnated female of *Ascaris mystax*, and found the formation of oil-drops in great quantity in its ova. By this, De la Valette was induced, quite independently of our investigations, to doubt Meissner's whole theory of the conversion of the spermatozoa.

It is not to be denied that the seminal corpuscles may enter upon a fatty metamorphosis. We find here and there in the genitalia of the females free corpuscles of a fatty aspect, which are possibly produced by the metamorphosis of seminal corpuscles. But even then it is a question whether this metamorphosis is a necessary step in the cycle of development of the seminal corpuscle, or whether the fatty metamorphosis is not a consequence of its death. However it may be, we must declare Meissner's observations to be insufficient, as he did not detect the formation of oil-drops in unfecundated eggs; and the question will not appear unsuitable, whether any of the oil-drops observed by Meissner in the eggs of *Ascarides* were ever produced by the metamorphosis of seminal corpuscles.

5. *On the Movements of the Seminal Corpuscles.*

Hitherto Schneider's observations upon the movements of the seminal corpuscles in the Nematoidea* have neither been confirmed nor controverted. It is scarcely possible to doubt the accuracy of the observations, as the report itself indicates great care in the investigation. We may, however, still ask whether the corpuscles in question were true zoospermia, or perhaps foreign beings, parasites; and, secondly, whether the movements observed were normal.

* Monatsber. der Berl. Akad., April 1856.

In recent times we have been constantly becoming more and more familiar with the idea, that the simplest elements of organic nature are not unfrequently endowed with a peculiar contractility, which resembles the mode of movement of the *Amœbæ*. Thus we have very recently been made acquainted by Leuckart* and Kölliker† with such phænomena in the cells of the liver of the Rabbit, in the cells of the mantle of the *Ascidia*, and in the cells of the ligamentous tissue in the *Torpedo*. The phænomena of motion discovered by Schneider in the seminal corpuscles of the Nematoidea would therefore be only a new member in this series of observations.

It was not Schneider, but Bischoff, that first attempted a comparison between *Amœbæ* and the seminal corpuscles of the Nematoidea. But in this comparison Bischoff had in his mind mere phænomena of diffusion, which he had detected in the seminal corpuscles of *Ascaris mystax*, and his observations have nothing to do with those of Schneider.

In accordance with Schneider's recommendations, we have opened the animals under examination, sometimes in white of egg, and sometimes in solutions of common salt or sugar. We never succeeded in any species in detecting phænomena of motion in the seminal corpuscles taken out of the seminal vesicle of the male. This was also the case with Schneider. The result was, however, very different when seminal corpuscles taken out of the tuba or out of the uterus were subjected to observation. Amongst the species examined, one is especially adapted for the investigation of the phænomena of motion in question; this is the *Strongylus auricularis*, which we shall therefore consider more particularly here.

In the first place, we are struck by the number of different corpuscles which occur besides the ova themselves within the female genitalia. Bagge‡ has already stated that the seminal vesicle of the male contains corpuscles of a form very different from those which he was inclined to regard as seminal corpuscles in the female. The former are the conical corpuscles, often resembling the horn of a chamois in form, which have already been mentioned. The second constitute round cells furnished with an elongated nucleus. This observation of Bagge's is perfectly correct, but incomplete. Not only the nucleated cells, but also corpuscles exactly similar to those from the male seminal vesicle, and besides these, others of an irregular form which

* Die Blasenbandwürmer und ihre Entwicklung. Giessen, 1856, p. 121.

† Sur les mouvements particuliers des cellules plasmatiques, &c. Gazette hebd. de Médecine, No. 48, 1856.

‡ De evolutione *Strongyli auricularis* et *Ascaridis acuminatæ*. Erlangæ, 1841.

cannot easily be described, occur in the female genitalia. When the corpuscles of the latter description are observed, we very soon detect in them the extension and retraction of processes—in a word, Schneider's *Amœba*-like movements. They do not all move at the same time, but the majority are usually quiescent; nevertheless we generally meet immediately with individuals engaged in movement. The movements are usually slow and heavy. Not unfrequently, however, we see a corpuscle, the movements of which were previously very slow and cautious, suddenly become more lively and execute several changes of form quickly one after the other, again acquiring its former indolence immediately afterwards.

It is easy to convince oneself that this has nothing to do with phænomena of diffusion, such as Bischoff has described in *Ascaris mystax*. The phænomena of motion go on for hours, and generally become even more lively when the seminal corpuscles have passed an hour in the fluid. That the corpuscles are not parasites, may be easily ascertained in *Strongylus auricularis*, because the seminal corpuscles of this species are of a very characteristic form. Thus we find every intermediate step from the immoveable forms of the zoospermia to the mobile corpuscles, as Schneider has already indicated. In the female sexual organs we meet first of all with conical and horn-like corpuscles, with the base sharply truncated, which agree perfectly with the zoospermia of the male. We also find in the female genitalia other corpuscles of exactly the same form, in which, however, the base is not simply truncated, but somewhat dilated and lobed. Even this form is capable of motion, but it is only the smaller lobed portion that takes part in the movement. The conical or horn-like apex is quite passive; it is dragged along, but executes no movement of its own. The further metamorphosis of the seminal corpuscle consists in the gradual enlargement of the lobed mobile base, whilst the immoveable apex diminishes in the same proportion. The firm apex gradually dissolves into the mobile, irregular portion. Finally, the apex completely disappears, and the corpuscle has a perfectly *Amœba*-like aspect. The cycle of metamorphosis is, however, not yet closed. A nucleus soon makes its appearance in the *Amœba*-like corpuscle, and gradually increases in length. The corpuscle then contracts into a ball, and extends its processes only from a particular side of its surface. The similarity between a seminal corpuscle of this kind and Bagge's nucleated cells is so striking, that no one can miss seeing it. There can be no doubt that the corpuscle with *Amœba*-like movements passes into a cell of this description. The question now is, whether the nucleated cell is a perfectly quiescent state of the seminal corpuscle, or whether it is still capable of motion.

Upon this point we can give no opinion. We have certainly seen nucleated cells furnished with very short processes which were still capable of motion, but we have never succeeded in detecting the extension of processes by nucleated cells which were not previously furnished with a single process.

Sometimes, moreover, females occur in which the last forms of the cycle of development of the zoospermia are wanting. These are undoubtedly such as have only been very recently impregnated.

We have made exactly similar observations in an *Ascaris* from the intestine of *Bufo cinereus*, which is nearly allied to *Ascaris acuminata*, and perhaps identical with *Ascaris commutata*, Diesing.

We have also confirmed Schneider's observations on *Cucullanus elegans*, although, in this case, from the small size of the seminal corpuscles, it is more difficult to convince oneself of the extension and retraction of the processes.

Lastly, we shall add, that, according to oral communications, Wagener and Lieberkühn have completely confirmed Schneider's discovery, in the animal mentioned by the latter in his memoir under the name of *Angiostoma Limacis*, Duj. But they assert that the worm in question is no *Angiostoma*, but an undescribed Nematoid worm.

There can consequently be no doubt about Schneider's discovery of the power of motion of the seminal corpuscles in the Nematoidea. The only question is, whether this faculty belongs to the seminal corpuscles of all the Nematoidea. In reference to this, we have in vain examined those of *Ascaris suilla* and *A. mystax*. In these we have been unable to detect any signs of movement. Nevertheless we can by no means deny that these seminal corpuscles possess some power of movement. Their flocculent extremity too closely resembles the lobed base of the seminal corpuscles of *Strongylus auricularis* for us to suppose that it is not an organ of motion. Perhaps in these zoospermia the movements are so slow that they have escaped us. Perhaps, also, we may not have hit the right degree of concentration of the solution of salt.

6. *Retrospect.*

In conclusion, we will sum up the principal results of this memoir:—

1. Bischoff's epithelial conules are seminal corpuscles, as Nelson, Meissner and Thompson have correctly asserted.

2. Meissner's female germ-cells have no existence. The representation given by this observer of the formation of the egg in the Nematoidea, must be regarded as entirely wrong.

3. The rhachis occurring in the vitellogene of certain Nematoidea is never an apparent one in Meissner's sense, but always an actual one.

4. Meissner's micropyle in the eggs of *Ascaris mystax* does not exist. Bischoff and Thompson have disputed its existence with perfect justice.

5. Whether the fecundation of the eggs is, or is not, effected by the penetration of the seminal corpuscles, remains undecided. At any rate, the observations published by Nelson and Meissner upon this point are insufficient to establish the penetration.

6. Meissner's theory of the conversion of the seminal corpuscles into fat is destitute of any solid foundation, and can by no means be sustained.

7. The formation of fat-drops takes place in great proportion in the unfecundated eggs.

8. Schneider's statement as to phænomena of movement in the seminal corpuscles of certain Nematoidea is founded upon very accurate observations, which are confirmed not only by our own, but also by those of G. Wagener and N. Lieberkühn.

XX.—*On the Investigation of Vegetable Tissue by the aid of Polarized Light.* By H. von Mohl*.

Polarized light offering a most sensitive means of discovering very slight differences, such as cannot be detected in any other way, between bodies which in every other respect behave exactly alike, the idea readily suggested itself of applying it in combination with the microscope to the examination of the structure of organic bodies. In addition to the isolated observations of Biot, Brewster, and others, we possess more comprehensive treatises on the investigation of vegetable tissue by means of the polarizing microscope, by K. von Erlach, Ehrenberg, and Schacht†. Of these, Erlach occupied himself more with the physical explanation of the phænomena which doubly-refracting substances exhibit on the polarizing microscope, than with extended researches upon vegetable structures.

The most general conclusion which Erlach drew from his researches was, that every organic substance of a certain thickness,

* Botanische Zeitung, January 1, 1858.

† Dr. Karl v. Erlach, Müller's Archiv f. Anat. u. Phys. 1847, p. 313. Ehrenberg, Bericht Berlin, Akad. 1849, p. 55. Schacht, Pflanzenzelle, 1852, p. 429; Lehrbuch d. Anat. u. Phys. d. Gewächse, 1855, i. p. 428. Whether the works of Bocck should be enumerated here, I know not, since I have not access to the originals, and the extract given by Hannover (Müller's Archiv, 1844) is too imperfect.